REMARKS

The present response is intended to be fully responsive to all points of objection and/or rejection raised by the Examiner and is believed to place the application in condition for allowance. Applicant asserts that the present invention is new, non-obvious and useful. Favorable reconsideration and allowance of the claims is respectfully requested.

Status of Claims

Claims 1-9 were previously pending in the application. Claims 1-9 have been cancelled without prejudice to refiling in a continuation or divisional. Claims 10-25 have been added. Accordingly, Claims 10-25 are now pending.

Applicant respectfully asserts that these amendments add no new matter.

Priority

In the Office Action, the Examiner asserted that Applicant's claim for the benefit of prior-filed provisional Application 60/422,231 does not comply with the requirements for receiving the benefit of an earlier filing data under 35 U.S.C. § 120. In particular, the Examiner asserted that previously pending Claims 5-8 are not adequately supported in the provisional application. As Claims 5-8 have been canceled without prejudice, it is respectfully submitted that the priority date of these claims is moot. Applicant, however, reserves all rights to address the priority of Claims 5-8 should further amendments reintroduce the subject matter of these claims, whether in the present application or a continuing application.

Claim Objections

In the Office Action, the Examiner objected to Claims 2-4 and 6-9 under 37 CFR 1.75(c), as being of improper dependent form for failing to further limit the subject matter of a previous claim. Although Applicant respectfully disagrees with this objection, Claims 2-4 and 6-9 have been canceled; as a result, it is respectfully submitted that these objections are no longer applicable.

CLAIM REJECTIONS

35 U.S.C. § 112 Rejections

In the Office Action, the Examiner rejected Claims 1-9 under 35 U.S.C. § 112, second paragraph, as being indefinite.

In particular, the Examiner objected to the terms "[possible] underlying asset values" in Claims 1 and 5, the terms "the volatility" in Claim 1, and the "wherein" clause in Claim 1. As the current claims do not include these terms, it is respectfully submitted that these rejections are no longer applicable.

Furthermore, the Examiner asserted that the terms "vega" and "node vega" are used interchangeably. Although Applicant disagrees, the claims have been amended to clarify the distinction between the two terms. In Applicant's Claims 10 and 17, the relationship between "node vega" and "vega for the binomial tree" is explicitly claimed as follows: "a value for vega for the binomial tree uses a function of the values for node vega." In Applicant's Specification, the term "vega" of the prior art is clearly defined in the paragraph bridging pages 6 and 7 and the term "node vega" of the claimed invention is clearly defined, e.g., on pg. 3, lines 2-5 and pg. 8 lines 5-13.

One distinction with respect to Claims 10 and 17, for example, is that prior vegas have been computed as a single value generated for an entire binomial tree (see pg. 7, lines 3-7), whereas, the present node vega is calculated for each node in the binomial tree (see pg. 7, lines 20-21). Another distinction with respect to Claims 11 and 18 is that prior vegas are numerically calculated approximations of a partial derivative of the option's price with respect to volatility. In contrast, the present node vega of Claims 11 and 18 is an exact partial derivative of the option price with respect to the volatility.

On page 5 of the Office Action, the Examiner states that "although Applicant refers to node vega as an exact derivative, applicant represents the term in equation (6) as a partial derivative." Applicant notes that the term "partial" in partial derivative means only that a derivative is taken with respect to one of multiple variables. Applicant notes that a partial

derivative *is* an exact derivative. It is the methodology of other parties which use numerically approximated derivatives (e.g., described on pg. 7, lines 3-7 of the present application), not exact derivatives.

Accordingly, Applicant respectfully requests that the Examiner withdraw the rejections under 35 U.S.C. § 112.

35 U.S.C. § 101 Rejections

In the Office Action, Claims 1-9 were rejected under 35 U.S.C. §101. It is submitted that all of the current claims are believed to present patentable subject matter.

It is further noted that the U.S. Supreme Court currently has a significant case pending concerning the scope of §101. *See, Bilski v. Doll*, Docket No. 08-964 (S. Ct. 2009). Among the questions being addressed is the legal standard for determining whether a process is patent-eligible subject matter under §101. Thus, it is believed that the outcome of that case may have significant impact on determination of the applicability of §101 here, and on the proper or best scope of the pending claims. In view thereof, it is respectfully requested and submitted that any further action under § 101 should be based on the Supreme Court's expected decision in that case and/or deferred until that decision is issued.

With respect to further modifications to the claims, if any, it is likewise submitted that determination of the best language for the claims requires, and will likely be impacted by, the guidance expected once a decision is issued in the *Bilski* case.

35 U.S.C. § 103 Rejections

In the Office Action, the Examiner rejected Claims 1-3, 5-7 and 9 under 35 U.S.C. § 103(a), as being unpatentable over Makivic et al. (U.S. Patent No. 6,061,662) and Claims 4 and 8 as being unpatentable over Makivic in view of Applicant's discussion of the Cox-Ross-Rubenstein (CRR) binomial tree.

Claims 1-9 have been cancelled. Therefore, it is submitted that the rejections thereof are no longer applicable. With respect to the new claims, it is respectfully requested that the Examiner withdraw the rejections under 35 U.S.C. § 103, for the reasons discussed below.

NEW CLAIMS

Applicant respectfully submits that each of new claims 10-25 are allowable over the cited art of record in view of the remarks that follow.

Each of Claims 10 and 17 includes, *inter alia*:

> [computing] a value for the implied volatility of [an] American option using a function of [a] value of vega computed for [a] binomial tree.

Makivic does not teach computing the implied volatility *of American options*. The only teaching in Makivic for computing implied volatility is to "[use] the Black-Scholes model and current market prices" (see Makivic col. 17 lines 5-8). Makivic refers to the teachings of Black and Scholes in J. Polit. Econ. 81, 637-59, 1973 (see Makivic col. 10 lines 16-18). In the Black Scholes model (1973), an option can only be exercised when the option expires (e.g., see the section entitled "Assumptions" in the website http://www.quickmba.com/finance/black-scholes/).

As explained in the present Application as filed, options that can only be exercised when the option expires are referred to as "European options" (see pg. 1, lines 22-23), while options that can be exercised prior to expiration are referred to as "American options" (see pg. 3, lines 8-9). Makivic only teaches calculating the implied volatility using the Black Scholes model (1973) for European options (options that can only be exercised at expiration). The present invention, in contrast, is directed to American options, options that can be exercised prior to expiration, which have different theoretical and practical issues associated therewith. Accordingly, it is submitted that Makivic's teachings are not applicable to Claims 10 and 17.

Likewise, each of Claims 10 and 17 includes, *inter alia*:

> [generating] a binomial tree having a plurality of nodes, each node corresponding to a different sub-period of time during which [an] American option can be exercised prior to the time when the option expires ... [and computing] a value for the implied

volatility of the American option using a function of the value of vega computed for the binomial tree.

With respect to the limitations required by these claims, Makivic does not teach or suggest the computation of multiple node vegas, each corresponding to a different sub-period of time during which an American option can be exercised prior to the time when the option expires.

It is noted that the Examiner equates kappa, $\kappa = \frac{\partial C}{\partial \sigma}$, in Tables 2 and 3 of Makivic with Applicant's node vega and the time periods N_t in Tables 2 and 3 of Makivic with Applicant's sub-periods of time. However, these quantities are very different. The time periods N_t in Tables 2 and 3 of Makivic are time periods to maturity (i.e., expiration) of European stocks (see Makivic col. 9 lines 48-49), i.e., the time remaining until the single fixed time, T, expires before which the stock cannot be exercised. These time periods, N_t, are not equivalent at all to the claimed multiple sub-periods of time when an American option can be exercised *prior* to expiration. The values for kappa, κ, in Tables 2 and 3 of Makivic correspond to different amounts of time remaining until a European option expires, not to different sub-periods of time during which an American option can be exercised *prior* to the time when the option expires. It is the latter which is recited in each of Claims 10 and 17.

In fact, Makivic itself teaches that it is non-obvious to use time periods and computations of European options for American options by stating that "[computing an option price] ... is not as simple for the American option [as for a European option], since the boundary is different for different time periods to maturity" (see Makivic col. 9 lines 48-51).

Applicant asserts that Tables 2 and 3 of Makivic, relied on by the Examiner to reject the claims, are directed to entirely different subject matter than Claims 10 and 17. Tables 2 and 3 of Makivic show "exemplary results" of "a valuation problem of a European call on a stock having constant volatility" (col. 18 lines 48-50). Accordingly, Makivic lists results of the price, <u>not</u> the implied volatility of an option -- the volatility is assumed to be constant.

Furthermore, the calculations are for European, not American options. Still furthermore, as explained above, the time periods N_t are the time periods to maturity, i.e., the times, t, until the single fixed time, T, when a European stock can be exercised, and are not applicable to the claimed American options which can be exercised prior to expiration.

Applicant notes that the only mention of "nodes" in Makivic are sub-routines of a parallel processor, which are clearly not nodes corresponding to different sub-periods of time during which the American option can be exercised prior to the time when the option expires.

Additionally, each of Claims 11 and 18 includes, *inter alia*:

> the value for node vega at each node is the exact derivative of the option price with respect to the volatility.

On pg. 8 of the Office Action, the Examiner agrees that Makivic does not expressly show calculations of an exact derivative of an option price with respect to volatility, but asserts that this feature is simply an obvious design choice since the invention fails to provide unexpected results. Applicant respectfully disagrees. Unexpected results of calculating an exact derivative, $\kappa = \frac{\partial C}{\partial \sigma}$, are described in the present Application, for example, on page 7, lines 1-13 and 20-23. To paraphrase this section, in the prior art vega (or kappa) is calculated numerically. That is, vega (or kappa) is approximated as $\kappa = \frac{\Delta C}{\Delta \sigma} = \frac{C_{\sigma(2)} - C_{\sigma(1)}}{\sigma(2) - \sigma(1)}$, where $C_{\sigma(2)}$ is the option price calculated for the volatility $\sigma(2)$ and $C_{\sigma(1)}$ is the option price calculated for the volatility $\sigma(1)$, "tweaked" by a small quantity from $\sigma(2)$. Calculating both $C_{\sigma(2)}$ and $C_{\sigma(1)}$ requires two iterations of the binomial tree calculations. The present invention however, provides a method for calculating the option price using the exact derivative from the calculated option price and volatility such that only one iteration of the binomial tree calculations is needed. This means that, calculating κ to be the exact derivative of an option price with respect to volatility reduces the iterative calculations by a half (from two iterations to one). This increases the efficiency of the computations by a two-fold amount, which is clearly a valuable and unexpected result. Accordingly, Claims 11 and 18 are not obvious in view of Makivic.

Each of Claims 11-16 and 18-25 depends from, directly or indirectly, one of Claims 10 and 17, and therefore includes all the limitations of one of these claims. Therefore, Applicant respectfully asserts that Claims 11-16 and 18-25 are likewise allowable.

Conclusion

In view of the foregoing amendments and remarks, Applicant asserts that the pending claims are all allowable. Should the Examiner have any question or comment as to the form, content or entry of this paper, the Examiner is requested to contact the undersigned at the telephone number below. Similarly, if there are any further issues yet to be resolved to advance the prosecution of this application to issue, the Examiner is requested to telephone the undersigned counsel.

In addition, the Commissioner is hereby authorized to debit any and all fees due in connection with this submission and application from our Deposit Account No. 50-3355.

Favorable reconsideration of the application and allowance are respectfully requested.

Respectfully submitted,

Morris E. Cohen
Attorney/Agent for Applicant(s)
Registration No. 39,947

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Pearl Cohen Zedek Latzer, LLP
1500 Broadway, 12th Floor
New York, New York 10036
Tel: (646) 878-0811 (direct);
Tel: (646) 878-0845 (secretary)
Fax: (646) 878-0801